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QUARTERLY REPORT

Project Title: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

For Period Ending: September 27, 2010
Contract No: DTPH56-09-T-000005
Prepared For: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

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Public Page for Quarter Ending September 27, 2010

Project #294: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

Background

Hydrogen is being considered as a promising candidate for alternative fuels. One key component of the hydrogen infrastructure is the delivery systems from the point of production to the point of use. Transporting gaseous hydrogen via existing pipelines is recognized as one of the most cost-effective options for delivering large volume of hydrogen. One of the major safety concerns has been performance degradation of pipeline materials under a high-pressure hydrogen environment. With extended exposure to high-pressure hydrogen, the mechanical properties of pipeline steels, including their tensile and yield strengths, fracture toughness, and crack-growth rate, may deteriorate. This could lead to significant reduction of service life of pipeline. As more and more high-strength pipelines have been put into service, there is a need for materials performance data under high-pressure hydrogen environment for high-strength steels. This project is intended to address these challenges. The objectives of this project are to produce performance data for high-strength steels used in hydrogen pipelines, use mechanistic-based analysis procedures and models for correlating the test data and predicting material behaviors under practical conditions. The test data and the analysis results will be used to enable updates and revisions of relevant industrial codes and standards.

Progress in the Quarter

The project activities undertaken in the fourth quarter included a number of new developments on project management. Progresses have been made in Task 1, Model Development, Task 2, Development of Test Equipment, Task 3, Fixture and Specimen Machining, and Task 4, Test Matrix Design.

The contract modification with DOT has been complete. The subcontract between CRES and NIST has been signed. A payment schedule for research funding from CRES to NIST has been agreed upon and the first payment was made during the fourth quarter. Another contract modification request to add a PREP graduate student to the project has been granted by DOT. Additional funding from DOT and cost-share from NIST for the PREP student program have been in principle approved. Under the coordination of Louis Hayden, information exchange and research collaboration between the current project and another DOT-sponsored project at Oak Ridge National Laboratory/University of Tennessee was initiated.

After extensive review of hydrogen embrittlement research works, an analytical approach for the modeling of stress-driven hydrogen diffusion during fatigue testing has been established. This approach offers the promises of efficient evaluation of hydrogen concentration at the crack tip and producing explicit correlation between the hydrogen degradation and the fatigue testing parameters.

Tasks 2, 3, and 4 have been started at NIST. The fabrications of the hydrogen test chamber and multi-specimen link system is in progress and the delivery is expected in mid-November. All the testing materials are on site at NIST, and the testing matrix has been further solidified. The fabrication of first group test specimens has been started.